REMARKS

This communication is a supplemental response to the response filed October 13, 2008 responding to the Final Office Action of July 17, 2008. The listing of claims provided reflects the amendments to the claims made in the response of October 13, 2008 and in which claim 1 is amended without prejudice. Specific support for this amendment is found in the as-filed specification. No new matter is added by way of this amendment. In this response, the applicant respectfully clarifies the arguments made with respect to the PEM fuel cell of Dodge and particular aspects of the fuel requirements of PEM and SOFC fuel cells. Appendices I-IV were provided in the October 13, 2008 response and are not provided herewith.

Claims 1-32 and 51-57 are rejected under 35 USC § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention. Specifically, it is unclear to the Office what is meant by "ceramic-type anode layer."

This rejection is overcome, at least, for the following reasons.

First, Applicant notes that ceramic-type materials used for anodes are well known to those of skill in the art. See, for example, "Ceramic Anodes for Corrosion Prevention", U.S. Army Corps of Engineers, provided herewith for the Examiner's convenience as Appendix I. Further, the specification discusses various types of ceramic or "cermet" materials used for solid oxide fuel cells at, for example, pages 2-3. However, in the interest of furthering prosecution and without prejudice, claim 1 has been amended herein to recite that the anode side comprises an anode layer comprising a ceramic material. Therefore, the rejection is overcome and should be withdrawn. Applicant respectfully requests same.

Claims 1-32 and 51-57 are rejected under 35 USC § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention. Specifically, it is unclear to the Office what is meant by "green material."

This rejection is overcome, at least, for the following reasons.

First, Applicant notes that one general meaning of the term "green" when used in the English language is:

7. Not seasoned; not dry;

Webster Dictionary, 1913.

Further, when used in a technical capacity specifically directed to the field of ceramics, "green" is used to connote parts that are "soft plastic, pliable, and will over time lose its shape." See, "Ceramic engineering" at page 2, Wikipedia.org, provided herein as Appendix II for the Examiner's convenience. Further attached hereto as Appendix III, for the Examiner's convenience, is a second article from Wikipedia from the section on "Ceramics." Page 5 of this article describes the production of a "green" body and its curing by the process of "sintering."

Finally, in the interests of confirming that the Office has previously examined and allowed claims using the word "green" in the context of ceramic or cermet materials, the Office's attention is directed to U.S. patent 6,221,289 to Corbett et al. (the '289 patent). As discussed in the present specification at, for example, pages 3-5, the '289 patent describes that a ceramic composition comprises a ceramic powder and a binder to form "green" elements for shaping and firing. See, '289 patent, abstract. Further, the '289 patent discusses how "sintering" of the "green" material results in the ceramic particles becoming bound together. '289 patent col. 1-col. 4. Thus, Applicant submits that the term "green", as used herein with respect to the formation of ceramic pieces, is a well understood term in the field of art and, further, its meaning in this respect is recognized by the Office.

To be complete, Applicant notes that "sinter" is a well accepted word in the English language defined as:

• **verb** cause (a powdered material) to coalesce by heating (and usually also by compression), without melting.

Compact Oxford English Dictionary, © Copyright Oxford University Press, 2008.

Thus, Applicant submits that, in fact, the term "green material" is well understood by those of skill in the art, and additionally, the U.S. Patent Office. The rejection is thus overcome and should be withdrawn. Applicant respectfully requests same.

Claims 1-8, 17-21, 51-57 are rejected under 35 USC § 103(a) as being unpatentable over Dodge (WO 96/04690) in view of Singh et al. (U.S. Patent No. 4,894,297).

This rejection is overcome, at least, for the following reasons.

The Office Has Misinterpreted The Claim

In the Office action at page 3 the Office states, "the term 'preformed' is functional language and imparts intended use to the structural features of the product. Therefore, while the intended use language of the claim has been considered, it is not given patentable weight because it is directed to a process and not directed to the structural features of the product." This statement is incorrect. Further, Applicant submits that the Office apparently has misunderstood the structural features derived from an "embedded" anode side current collector derived from the preformed tubular structure because the Office has, apparently, misunderstood the term "green" as used by those of skill in the art of ceramics. This is discussed below. Further, the Office continues its rejection by saying that "[A] claim containing a recitation with respect to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus if the prior art apparatus teaches all the structural limitation of the claim." In support of this statement, the Office cites to MPEP 2113. However, MPEP 2113 is directed to a product by process claims. In the instant case, the claim describes that the tubular metallic structure is "at least party embedded in the anode layer and reinforces the anode layer." This "structural feature" of the invention is derived from the fact that the tubular metallic structure is embedded in the anode layer, which is made possible because the anode layer is applied to the tubular metallic structure while it is 'green' before it is sintered." Therefore, Applicant submits that, first, the claim does not recite a product by process claim; and second, the claim does recite structural language which does distinguish the present invention from the prior art.

Dodge Discloses A Hydrogen Fuel Cell, Not A Solid Oxide Fuel Cell

Dodge discloses a "hydrogen fuel cell assembly employing a wet perfluorsulfonic acid electrolytic membrane." See, Abstract. This particular type of hydrogen fuel cell is also known as a "Polymer Electrolyte Membrane Fuel Cell" (PEMFC) or a "Proton Exchange Membrane Fuel Cell" (PEMFC). Instant claim 1 and claims 2-8, 17-21 and 51-57, which depend ultimately therefrom, ***require*** the invention to be a "tubular solid oxide fuel cell." While these different

types of fuel cells share the characteristic of producing electricity by the oxidation of a fuel, they are not interchangeable and/or compatible with each other. In this regard, the Applicant provides herewith, for the Examiner's convenience, a survey of different types of fuels cells from "fuel cell works" as Appendix IV, available on the internet at: http://fuelcellsworks.com/typesoffuelcells.html. As described in Appendix IV, there are at least 9 major kinds of fuel cells, two of which are the "Polymer Electrolyte Membrane" (PEM) and the "Solid Oxide." Further, as discussed in Appendix IV, the fuel source for the PEM is hydrogen. This is also stated by Dodge: "Disclosed embodiments include a self-contained portable fuel cell in which the cell is shaped to accommodate a canister of hydrogen fuel and an array of cell arranged around a common hydrogen fuel tank or canister." Dodge, Abstract. Thus, the fuel type used by Dodge is explicitly recited as well.

As discussed in Appendix IV, the requirements of the PEM fuel cell (described on page 1) and those of the SOFC (discussed on page 3) are very different. Specifically, PEM fuel cells are fueled with pure hydrogen and are able to operate at temperatures of about 80° C, one major benefit of which is allowing quick start up and less wear. Appendix IV at 1. However, such low temperatures also require the use of a noble-metal catalyst (typically platinum) to be used to separate the hydrogen's electrons and protons. See, Id. This requirement makes the PEM more expensive, but also, the platinum catalyst is extremely sensitive to CO poisoning, making it necessary to employ an additional reactor to rescue CO in the fuel gas if the hydrogen is derived from an alcohol or hydrocarbon fuel. See, Id. Thus, the necessity requiring Dodge, to provide the canister of hydrogen fuel as discussed above.

That Dodge describes a PEM fuel cell is explicitly stated. "In my U.S. Patent No. 5,336,570 . . . I disclosed a lightweight and portable hydrogen fuel cell of the proton-exchange membrane type. . . . drawbacks of the constructions set forth in my U.S. Patent '570 relate to ease and cost of fuel cell of the type disclosed in my U.S. Patent '570 which was easier and less expensive to manufacture. It would furthermore be desirable to have a fuel cell of the type disclosed in my Patent '570 which was easier and less expensive to manufacture." Dodge at page 2, lines 19-42. "In accordance with the invention, an easy to manufacture, light-weight fuel cell" that "promote engagement of the electrodes with the cells' electrolytic membrane is provided." Id. at page 3, lines 34-39. "[T]he invention provides a hydrogen fuel cell which is shaped to receive and embrace ***a hydrogen supply canister*** to provide a self-contained portable

electricity generating unit." Id. at page 4, lines 26-29 (emphasis added). Further, "[I]n the embodiment of Figure 2, flat laminar fuel cell assemblies 860, each comprising a proton exchange membrane sandwiched between cathodic and anodic electrodes are interspersed between gas-distribution plates 862." Id. at page 10, lines 29-33 (emphasis added).

In contrast, the SOFC, is specifically designed to operate at temperatures around 1000° C. Appendix IV at 3. This high operating temperature is facilitated by the use of a hard, non-porous ceramic compound used as the electrolyte. Id. Further, the high temperature operation removes the need for the precious metal catalyst. This benefit allows the SOFC to use a variety of fuels and reduces the cost associated with providing a separate reformer for the system, even if pure hydrogen is not provided as the fuel, as is contemplated by Dodge. Further, SOFCs are not poisoned by CO which can, in fact, be used as a fuel component in SOFCs. Id. This characteristic even allows SOFCs to use gas made from coal as a fuel. See, Id. However, while high temperature operation allows for versatility in fuel source, it also "has disadvantages. It results in a slow startup and requires significant thermal shielding to retain heat and protect personnel, which may be acceptable for utility applications but not for transportation and small portable applications." Id.

Dodge Would Not Function With A Solid Oxide Electrolyte

Applicant points out that solid oxide fuel cells and PEM fuel cells are not compatible. This is true for several reasons, not the least of which is that PEM require pure hydrogen which may be provided, typically, in the form of a compressed gas, requiring the provision of a "hydrogen supply canister" as described by Dodge (see, above). In addition, were one to use an unreformed fuel in the PEM, it would destroy the PEM as discussed above. Further, as discussed in Appendix II, PEM fuel cells use a solid polymer as an electrolyte (e.g., the electrolytic membrane) and porous carbon electrodes containing a platinum catalyst. In contrast, a solid oxide fuel cell uses a "solid oxide" as the electrolyte and electrodes that are not carbon containing platinum catalyst. This requirement is clearly shown in the schematic on page 4 of Appendix IV. Thus, the electrolyte and electrodes of one fuel cell would not work as the electrolyte and electrodes of another fuel cell type .

Thus, Dodge can not work to make the present invention obvious as Dodge teaches a different type of fuel cell with different requirements, different electrolyte, different operating

temperatures, different anode, different cathode, etc. Dodge simply provides none of the elements required of a solid oxide fuel cell.

Singh Does not Remedy the defects of Dodge

While Singh does disclose a solid oxide fuel cell, the fuel cell described by Singh includes, from the inside out, a tubular support tube, a cathode deposited onto the support tube, an electrolyte deposited onto the cathode and an anode. In contrast, the instant claims *require*, from the inside out, an anode side current collector at least partially embedded in an anode layer, the anode layer having a solid oxide electrolyte applied thereto, a cathode layer followed by a cathode side current collector. Thus, the very structure of Singh is different in, at least, requiring a non-functional support tube, a cathode where the instant anode side-current collector/anode is found in the present invention and an anode and anode current collector where the cathode is found in the present invention. Thus, Singh does not teach all the elements of the present claim, nor could Singh be modified to do so, as Singh requires, at least, a non-operational tube functioning only as a mechanical support. The rejection is therefore overcome and should be withdrawn. Applicant respectfully requests same.

The Combination of Dodge and Singh Does Not Yield the Present Invention

Claim 1 and claim 2-8, 17-21 and 51-57, depending therefrom, *require* a solid oxide fuel cell comprising an anode side defining a tubular passage, a ceramic-type anode layer, an anode-side current collector in electrical contact with the anode layer and at least partially embedded therein, a solid oxide electrolyte layer on a radially outer surface of the anode layer, a cathode layer on a radially outer surface of the electrolyte layer and a cathode-side current collector on the cathode layer. One embodiment of this arrangement is illustrated in Fig. 1 of the application.

As discussed above, Dodge does not disclose a solid oxide fuel cell and, thus, cannot use a solid oxide electrolyte layer. As discussed by Dodge, the electrolyte is a wet perfluorsulfonic acid electrolytic membrane. See, for example, the Abstract. Further, where the hydrogen fuel cell of Dodge is tubular the innermost component is simply a "hollow" member (910). See for example, page 11, line 13. The porous member provides a support for a "first conductive winding 916", which is titanium wire having a platinum coating or a platinum plating. Thus, the anode is not ceramic and is not tubular but is, rather, wound around a tubular support. Further, in Dodge the electrolyte layer is a perfluorosulforic acid film (such as Nafion). Significantly, this

type of electrolyte layer has operating temperatures of only up to 190° C. (See, for example, Nafion: Physical and Chemical Properties, http://www.permapure.com/TechNotes/Nafion%20physical%20&%20chemical.htm). Significantly, Nafion-type electrolytic membranes are not oxides at all but a sulfonated tetrafluorethylene copolymer.

Singh, similarly, discloses only a tubular support member that is mechanical but not operative. As discussed above, the elements of Singh are, further, in the wrong order to result in the present invention. Finally, if Singh were combined with Dodge, not only would the result not be operable but, further, it would not result in the present invention, not least because both Dodge and Sing require a non-functional hollow support tube that are further surrounded by elements not disclosed, required or functional in the present invention. Thus, the rejection of Dodge in view of Singh is overcome and should be withdrawn.

The Office Has Failed To Make A Prima Facie Case Of Obviousness

Because the Office bases the rejection on the conclusion that "Dodge discloses . . . a tubular solid oxide fuel cell" and because Dodge clearly does not disclose a "solid oxide fuel cell." The Office's *prima facie* case is not tenable. Further, Applicant notes that PEM and SOFC fuel cells operate at very different temperatures. Specifically, Applicant directs the Office's attention to Dodge: "[T]ubular and tapered tubular embodiments of the fuel cell, such as those shown in Fig. 13, are particularly well adapted to function at ***relatively low, albeit elevated temperatures (circa 80-100° C)***, with wet-operating electrolytic membranes." Page 30, lines 25-28 (emphasis added). While this operating temperature is exactly within the range for PEMFC identified in the chart comparing various fuel cell types, the operating temperature for SOFTC is 600-1000° C. Further, this is expressly stated in the present application, SOFC's operate in the vicinity of 700-1000° C. Pg. 2, line 1. Further, while a decrease in operating temperatures for SOFC's would be desirable, such SOFC's have not been developed. Again, the Office's attention is directed to Appendix IV, Scientists are currently exploring the potential for developing lower-temperature SOFC's operating at or below 800° C . . . however, and stack materials that will function in this lower temperature range have not been identified." See, Appendix IV at page 3. Therefore, Dodge could not operate at the temperature levels required for a solid oxide fuel cell, even if it could conceivably be modified to do so. One of skill in the art might hazard a guess at what would happen to a canister of hydrogen heated to a temperature

of 800-1000° C. For this reason alone, the rejection is overcome and should be withdrawn. Applicant respectfully requests same.

Singh Is Incompatible With Dodge

As discussed above, Dodge discloses a PEM fuel cell that operates at the ***relatively low, albeit elevated temperatures (circa 80-100° C)***. In contrast, Singh discloses electrochemical cells that have a solid oxide electrode and are operated at over 800° C. See, Abstract. Thus, Applicant submits that the combination made by the Office simply would not work, not least because Dodge requires pure hydrogen as a fuel source lest the catalyst be destroyed and Dodge requires an electrolyte that comprises a wet membrane. See Dodge, page. 19, line 43-page 20, line 1. Dodge, simply requires an operating temperature that is far below that of Singh, neither, is compatible with the other. Thus, the combination of Dodge in view of Singh simply does not result in the present invention which requires a "tubular solid oxide fuel cell." Therefore, at least for this reason, the rejection is overcome and should be withdrawn. Applicant respectfully requests same.

The Combination Made by the Office Is Inoperable

Finally, Applicant points out that the combination made by the Office simply cannot work. First the Office states that "the arrangement of the solid oxide fuel cell of Singh has been reversed into an inverted cell structure from that of the solid oxide fuel cell of Dodge. However, the components are the same and perform the same function even in the reverse order." Office Action at page 4. This is a patently inapposite statement. As discussed above, Dodge does not disclose a solid oxide fuel cell. Dodge requires operating temperatures of between 80 and 100° C. There is simply no way that Dodge could be modified by Singh to result in a solid oxide fuel cell. There is no way that a solid oxide fuel cell could operate at *"elevated"* temperatures of between 80-100° C. One of skill in the art could not combine Dodge and Singh and arrive at a tubular solid oxide fuel cell of the present invention. Therefore, for this reason alone, the rejection is overcome and should be withdrawn. Applicant respectfully requests same.

The Combination Of Dodge And Singh Would Destroy The Utility Of Dodge

Dodge discloses "A ***lightweight*** hydrogen fuel cell assembly employing a wet perfluorosulfonic acid electrolytic membrane . . . embodiments include a ***self-contained portable***

fuel cell in which the cell is shaped to accommodate a canister of hydrogen fuel and an array of cells arranged around a common hydrogen fuel tank or canister." Dodge, Abstract. Further, Dodge discusses "It would furthermore be desirable to have a fuel cell of the type disclosed in my Patent '570 which was easier and less expensive to manufacture." Id. at page 2, lines 19-42. As disclosed by Dodge, features that are particularly desirable are its **light weight**, **portability** and **ease of manufacture**. However, as further discussed above, due to the high operating temperatures required by SOFC's, attempting to operate Dodge, somehow redesigned as a SOFC according to Singh, would not result in a light weight, portable or easy to operate fuel cell because, as discussed in Appendix IV, the very high operating temperatures require "significant thermal shielding to retain heat and protect personnel" which "**may be acceptable for utility applications *but not for transportation and small portable applications***." Appendix IV at 3. Therefore, Applicant submits that the combination made by the Office would destroy the utility of Dodge, which would be inoperable, in any case and therefore teaches against making the combination made by the Office. At least for these reasons, the rejection is overcome and should be withdrawn.

Claims 9-16 are rejected under 35 USC § 103(a) as being unpatentable over Dodge (WO 96/04690) in view of Singh et al. (U.S. Patent No. 4,894,297) as applied to Claims 1-8, 17-21, 51-57 above, and in further view of Will (U.S. Patent No. 4,347,429).

This rejection is overcome, at least, for the following reasons.

Will Does Not Rectify The Deficiencies Of Dodge And Singh

The combination of Dodge and Singh is inoperable. As discussed above, Dodge does not disclose a solid oxide fuel cell and Dodge could not be modified to result in a solid oxide fuel cell. Singh does not rectify the deficiencies of Dodge and the two simply could not be combined to form any functional type of fuel cell.

Will does not disclose a tubular solid oxide fuel cell. Will discloses an electrode boiler containing an aqueous electrolyte provided with a pair of spaced electrodes immersed in the electrolyte and connected to an AC power source. Neither Dodge nor Singh, alone or in combination, disclose a tubular solid oxide fuel cell. Therefore, the addition of Will cannot make obvious the independent claims and, further, the rejection of dependent claims 9-16 cannot

stand. The rejection of claims 9-16 being thus overcome, withdrawal of the rejection is respectfully requested.

Claims 22-27 are rejected under 35 USC § 103(a) as being unpatentable over Dodge (WO 96/04690) in view of Singh et al. (U.S. Patent No. 4,894,297), as applied to Claims 1-8, 17-21, 51-57 above, and in further view of Isenberg (EP 0055016 A1).

This rejection is overcome, at least, for the following reasons.

Isenberg Does Not Remedy The Defects Of Dodge And Singh

The combination of Dodge and Singh is inoperable. As discussed above, Dodge does not disclose a solid oxide fuel cell. Dodge is incompatible with Singh. The combination of Dodge and Singh would not work as Dodge could not operate at temperatures of 800-1000° C and Singh could not operate at temperatures of 80-100° C. Inability to operate would be further hindered by the fact that the two fuel cells taught by Dodge and Singh use different fuel sources.

Isenberg is cited for the proposition that it teaches a "cathode layer of discontinuous length along the assembly to provide a plurality of longitudinally spaced cathode portions." Office Action at page 9. However, Isenberg does not teach a tubular solid oxide fuel cell. Further, Applicant points out that Isenberg is incompatible with Dodge. Dodge discloses a PEM fuel cell that operates at temperatures of 80-100° C. In contrast, Isenberg is related to a solid electrolyte fuel cell that operate at above 700° C. Thus, Applicant submits that Isenberg does not rectify the deficiencies of Dodge and Singh and, further, is incompatible with Dodge as neither apparatus would be functional at the operating temperature of the other. The rejection being therefore overcome, withdrawal is respectfully requested.

Claims 28-29 are rejected under 35 USC § 103(a) as being unpatentable over Dodge (WO 96/04690) in view of Singh et al. (U.S. Patent No. 4,894,297), as applied to Claims 1-8, 17-21, 51-57 above, and in further view of Sammes (WO 99/17390).

This rejection is overcome, at least, for the following reasons.

Sammes Does Not Remedy The Defects Of Dodge And Singh

The combination of Dodge and Singh is inoperable. As discussed above, Dodge does not disclose a solid oxide fuel cell. Dodge is incompatible with Singh. The combination of Dodge and Singh would not work as Dodge could not operate at temperatures of 800-1000° C and Singh

could not operate at 80-100° C. Inability to operate would be further hindered by the fact that the two fuel cells taught by Dodge and Singh use different fuel sources.

Sammes does not cure the defects of Dodge and Singh. Sammes discloses a solid oxide fuel cell. As discussed above, solid oxide fuel cells require operation at temperatures of about 700-1000° C. Sammes requires operation at temperatures of between 600-1000° C. Therefore, Sammes not only does not cure the defects of Dodge, the combination of Sammes and Dodge is inoperable because Dodge requires operation at temperatures of 80-100° C. The combination simply would not work. The rejection being thus overcome, withdrawal is respectfully requested.

Claims 30-32 are rejected under 35 USC § 103(a) as being unpatentable over Dodge (WO 96/04690) in view of Singh et al. (U.S. Patent No. 4,894,297), as applied to claims 1-8, 17-21, 51-57 above, and in further view of Goodenough (U.S. Patent No. 6,004,688).

This rejection is overcome, at least, for the following reasons.

Goodenough Does Not Cure The Defects Of Dodge And Sammes

The combination of Dodge and Singh is inoperable. As discussed above, Dodge does not disclose a solid oxide fuel cell. Dodge is incompatible with Singh. The combination of Dodge and Singh would not work as Dodge could not operate at temperatures of 800-1000° C and Singh could not operate at temperatures of 80-100° C. Inability to operate would be further hindered by the fact that the two fuel cells taught by Dodge and Singh use different fuel sources.

Goodenough discloses a planar, solid oxide fuel cell and perovskite lanthanum gallate electrolyte. Goodenough discloses an "improved" electrolyte that has the highest conductivity at 800° C and 700° C, respectively. Goodenough at col. 2, lines 50-51. Dodge requires operation at 80-100° C. Therefore, Goodenough does not teach a tubular solid oxide fuel cell and is incompatible with Dodge. Dodge further does not teach a solid oxide fuel cell at all and is incompatible with Goodenough. The rejection is therefore overcome and should be withdrawn. Applicant respectfully requests same.

Conclusion

In view of the foregoing, it is respectfully submitted that the claims of record are allowable and that the application should be passed to issue. Should the Examiner believe that the application is not in a condition for allowance and that a telephone interview would help further prosecution of this case, the Examiner is requested to contact the undersigned attorney at the phone number below.

Respectfully submitted,

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